TWO SPRUCE-INFECTING RUSTS CHRYSOMYXA PIPERIANA AND CHRYSOMYXA CHIOGENIS

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Chrysomyxa Piperiana (Arthur) Sacc. & Trott. is a common rust on the Pacific slope of the northwestern United States, and within that region has been collected in Washington, Oregon and northern California. Up to the present it has been recognized on *Rhododendron macrophyllum* Don (*Rh. californicum* Hook.) only, and on that host in its uredial stage only. The earlier collections were usually labelled *Chrysomyxa Rhododendri* DeBary, but evenually Arthur diagnosed it as a new species and described it from its uredia under the name *Melampsoropsis Piperiana*. Recent successful infection experiments, however, conducted in the greenhouses of the Arnold Arboretum, demonstrate that *Peridermium Parksianum* Faull on *Picea sitchensis* (Bong.) Carr. is the haploid phase of this rust. Moreover, abundant telia, teliospores and basidiospores have been discovered in material collected in Oregon by Dr. G. D. Darker. So it is now possible to present a complete taxonomic description of *Chrysomyxa Piperiana*.

The cultures referred to were made by sowing the aeciospores of *Peridermium Parksianum* on two small potted plants of *Rhododendron macrophyllum;* two similar ones served as controls. All four were grown from seed of British Columbia origin, sown February 8, 1928 by Mr. William H. Judd at the Arnold Arboretum. The greenhouses were entirely free from Rhododendron rust of any kind.

The aecial material used as inoculum was collected by Mr. H. E. Parks at Trinidad, Humboldt County, California, November 23, 1933 and sent in fresh condition by air mail. The aeciospores were sown five days later. A relatively small percentage of the spores germinated, but with the liberal amount employed the number was amply sufficient. Within a month to six weeks many small yellow lesions developed on the inoculated plants. Thereafter until early April the lesions, some of them slightly swollen, seemed to remain in a somewhat stromatic resting condition. Then hypophyllous uredia, usually about one to a lesion, began to form on several of the lesions. The first discharge of urediospores was noted April 27, 1934. Careful studies of both uredia and urediospores were promptly made. Fortunately, herbarium material (a single rusted leaf) was harvested prior to serious fumigation injury

in June. The control plants remained throughout without any sign of infection.

The discharged urediospores were yellow, ellipsoidal or linear, often attenuate at one or both ends, straight or slightly curved. Their walls were hyaline, closely tuberculate and 1.5–3.0 μ thick. Forty spores from the same sorus measured 16.0–27.4 × 27.4–68.5 μ and averaged 22 × 46 μ. Razor sections of the uredia showed that the spores were borne catenulately and separated by intercalary cells. They also revealed the presence of a well-marked peridium. The peridium consists of a single layer of laterally adherent cells, the terminal cells of the urediosporogenic, primordial columns. The finding of a peridium clashes with current descriptions of the uredium of *C. Piperiana*. But sections of type material or other field-collected specimens show exactly the same kind of peridium as found in my cultures. Indeed, the rust as obtained in cultures answers in all respects to *C. Piperiana*.

With regard to the telia, lack of acquaintance with them is probably due to the fact that they are of brief duration, their occurrence coinciding with a short period of susceptibility to infection of young spruce needles; and so they have been missed by collectors. They surely cannot be rare. Once familiar with their appearance, remains of them can be detected in many existing collections. It is likewise probable that this rust is not infrequent on spruces within its range. Recognition is easy because of the striking microscopic characters of both spermogonia and aeciospores.

Chrysomyxa Piperiana (Arthur) Sacc. & Trott. in Syll. Fung. **21**: 716 (1912). (II.) O, I, II and III.

Melampsoropsis Piperiana Arthur in North Am. Flora, **7**: 120 (1907). II.

Caeoma Piperianum (Arthur) Sacc. & Trott. in Syll. Fung. **21**: 787 (1912). II.

Peridermium Parksianum Faull in Jour. Arnold Arb. **15**: 86 (1934). O, I.

O. Spermogonia on needles of current season, hypophyllous, numerous, biseriate, conspicuous, yellowish, then reddish-brown, slightly elevated, aparaphysate, immersed, subtriangular in vertical section, subepidermal, 228–315 μ broad and 125–155 μ deep, averaging 260 × 140 μ; spermatiophores unbranched; spermatia globose to broadly ellipsoidal, 2.7–3.2 × 3.0–5.0 μ.

I. Aecia (peridermia) on needles of current season, yellow, hypophyllous, irregularly biseriate, on yellowish discolored portions of affected needles, circular or somewhat laterally compressed in transverse section, cylindrical, 0.4–1.2 mm. in diameter and 1.0–2.2 mm. high;

peridium colorless, rupturing at the apex; peridial cells polygonal, elongate vertically, subimbricate, in a single layer, 18–26 × 48–88 μ, with outer walls smooth, 0.7–1.0 μ thick, and inner walls finely verrucose, about 1.5 μ thick; aeciospores yellow, fusiform or narrowly ellipsoidal, straight or curved, rarely subglobose, 13–24 × 25–111 μ, usually fusiform and averaging about 16 × 70 μ; walls of aeciospores densely and finely warted, hyaline and about 1 μ thick.

II. Uredia hypophyllous, pustular, waxy before rupture, subepidermal, 0.2–0.4 mm. in diameter, on solitary or aggregate areolae that constitute the pale green to yellowish brown lesions, one each to an areola; peridium distinct, 10–14 μ thick; peridial cells in a single layer, angular, thin-walled, 13–19 μ in diameter; urediospores yellow, catenulate, with intercalary cells, pulverulent as discharged, or extruded in a cylindrical column (resembling the telial column of a *Cronartium*) from the apically ruptured uredium, ellipsoidal to linear, often narrowed towards each end, straight or slightly curved, 14–27 × 27–100 μ, averaging 16–21 × 41–67 μ; walls of spores hyaline, 1.5–3.0 μ thick, coarsely and closely verrucose.

III. Telia on overwintered leaves, hypophyllous, yellow, pulvinate, waxy, rupturing widely at maturity and eventually becoming concave, subepidermal, one or two to an areola on solitary or aggregate areolae that constitute the pale green to yellowish brown lesions, subcircular, 0.2–0.5 mm. in diameter; no peridium; teliospores yellow, catenulate, 3 to 6 or more spores in a chain, without intercalary cells, smooth, thin-walled, 11–16 × 13–22 μ. The teliospores germinate in situ at maturity and in centripetal order. Basidia slightly curved to strongly arched, 4-celled, 7–8 μ thick and up to 40 μ long. Basidiospores subglobose, 8–11 μ in diameter.

The foregoing description of telia is based on two collections of overwintered leaves — (a) Still Creek, Clackamas Co., Ore., elev. 3500 ft., July 7, 1929, *G. D. Darker* (2682), Arnold Arb. Path. Herb. no. 179; (b) Rhododendron, Clackamas Co., Ore., elev. 2000 ft., July 9, 1929, *G. D. Darker* (2697), Arnold Arb. Path. Herb. no. 194.

The sequence of spore production on overwintered Rhododendron leaves seems to be — uredia in spring, telia during period of susceptibility to infection of new spruce needles, then a copious crop of uredia.

Chrysomyxa Chiogenis Dietel is a rust long known on *Chiogenes hispidula* (L.) Torrey & Gray, both as to its uredia and telia. Though it has been reported from Wisconsin, Newfoundland and northern New York only, it is much more widely distributed. Thus, herbaria in Harvard University contain, in addition, collections from Ontario, Quebec,

TABLE 1

Chrysomyxa Chiogenis from *Chiogenes hispidula* to *Picea glauca* (Moench) Voss.

Date of inoculation	First appearance of lesions	First appearance of peridermia	Date harvested	No. of needles infected	No. of needles with peridermia
23.vi.24	15 days	29 days	5.viii.24	53	47
24.vi.24	16 "	35 "	5.viii.24	20	19
24.vi.24	——	30 "	5.viii.24	1	1
17.vi.25	——	35 "	5.viii.25	—	5
17.vi.25	——	35 "	5.viii.25	—	25
17.vi.25	——	33 "	1.viii.25	—	38
16.vi.28	12 days	——	31.vii. 28	14	7
16.vi.28	12 "	——	31.vii. 28	92	42

TABLE 2

Chrysomyxa Chiogenis from *Chiogenes hispidula* to *Picea mariana* (Mill.) B.S.P.

Date of inoculation	First appearance of lesions	First appearance of peridermia	Date harvested	No. of needles infected	No. of needles with peridermia
25.vi.24	——	——	10.ix. 24	2	2
17.vi.25	——	35 days	5.viii.25	20	12
17.vi.25	——	35 "	17.viii.25	10	4

TABLE 3

Chrysomyxa Chiogenis from *Picea glauca* to *Chiogenes hispidula*

	Experiment 1	*Experiment 2*
Source of inoculum	Experiment 1 of Table 1	Experiments 4 and 5 of Table 1
Date of inoculation	August 8, 1924	August 5, 1925
First indication of lesions	September, 1924	September, 1925
First appearance of sori	Late May, 1925	About June 1, 1926
Date harvested	June 5, 1925	June 20, 1926
No. of inoculated branches	2	5
Leaves on inoculated branches	113	120
Leaves infected and with sori	19	65
Kinds of sori	Uredia and young telia (?)	Uredia and telia

New Brunswick and New Hampshire. Doubtless its range is much greater still. In some localities it is common; but even in such places, because of its inconspicuousness, it easily escapes detection unless the prostrate branches of its host are turned over for inspection.

So far no host other than the creeping snowberry has been recognized for this rust, but successful infection experiments summarized below demonstrate that at least two species of *Picea* can serve as hosts for the haploid phase. These experiments were conducted at the field laboratory of forest pathology on Bear Island in the Timagami Forest Reserve, Ontario; and in connection with them I gratefully acknowledge the assistance afforded by Mr. W. R. Watson, Professor E. H. Moss and Dr. G. D. Darker.

The numbers of uredia on the infected leaves of experiment 1 were, respectively — 18, 16, 35, 24, 17, 45, 20, 26, 51, 38, 34, 75, 40, 56, 36, 24, 32, 28, 19. Experiment 1 was conducted on a potted plant at the laboratory; Experiment 2, on an undisturbed plant in a carefully selected spot in the field in which no rust could be found and which was well protected from chance infection. Uninoculated branches of the experimental plants served as controls, and in addition surrounding plants in experiment 2. All controls remained free from rust except that in experiment 1 seven uredia were found on a 4-leaved twig on a branch immediately below the inoculated branches.

Chrysomyxa Chiogenis Dietel in Bot. Gaz. **19:** 303 (1894). (II.) I, II and III.

Melampsoropsis Chiogenis (Dietel) Arthur in Rés. Sci. Congr. Bot. Vienne, p. 338 (1906). II.

O. Spermogonia unknown; apparently lacking.

I. Aecia (peridermia) on needles of current season, yellow, hypophyllous, biseriate, on yellowish discolored portions of affected needles, lenticular to subcircular in transverse section, 0.5–1.2 mm. long and 0.5–1.5 mm. high; peridium colorless, rupturing at the apex; peridial cells polygonal, elongate vertically, not imbricate, in a single layer, 16–32 × 30–45 μ, with outer walls smooth, 0.5–1.0 μ thick, and inner walls verrucose, the warts often in short lines, 2.5–3.0 μ thick; aeciospores yellow, ellipsoidal to subglobose, 15–18 × 19–30 μ, averaging about 16 × 24 μ; walls of aeciospores closely and rather finely to subcoarsely warted, hyaline and 2–3 μ thick.

II. Uredia hypophyllous, pustular, subepidermal, circular to elliptical, 0.2–0.7 mm. in major axis; peridium distinct, 13–16 μ thick; peridial cells in a single layer, angular, thin-walled, 10–13 μ in diameter;

urediospores yellow, catenulate, with intercalary cells, pulverulent, ellipsoidal, rarely subglobose, 12–19 × 18–32 μ, averaging about 16 × 22 μ; walls of spores hyaline, closely and rather finely verrucose, 2.0–2.5 μ thick.

III. Telia on overwintered leaves, hypophyllous, yellow, flat, waxy, rupturing widely at maturity, subepidermal, subcircular to elliptical, 0.3–0.7 mm. in major axis; no peridium; teliospores yellow, catenulate, up to 6 or more in a chain, without intercalary cells, smooth, thin-walled, 11–15 × 12–19 μ. The teliospores germinate in situ at maturity. Basidia slightly curved to strongly arched, 4-celled, 7–8 μ thick and up to 43 μ long. Basidiospores subglobose, 7–9 μ in diameter.

The description of aecia given above is from culture material in Herbarium J. H. Faull: (a) on *Picea glauca* (Moench) Voss (*P. canadensis* [Mill.] B.S.P.), nos. 7305, 7304 and 7302; (b) on *Picea mariana* (Mill.) B.S.P., nos. 7307 and 7308.

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